Lecture Module - Electrical Signals

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

Topic 1 - Classification of Signals

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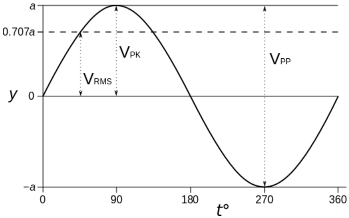
- Introduction to Signal Concepts
- Analog, Discrete, or Digital
- Static or Dynamic
- Deterministic or Non-Deterministic

Introduction to Signal Concepts

Signal, Amplitude, and Frequency



The shape and form of a signal are often referred to as its waveform. The waveform contains information about the magnitude and amplitude, which indicate the size of the input quantity, and the frequency, which indicates the way the signal changes in time.

Text: Theory and Design for Mechanical Measurements

Introduction to Signal Concepts

A signal is the physical information about a measured variable being transmitted between a process and the measurement system, between the stages of a measurement system, or as the output from a measurement system.

Text: Theory and Design for Mechanical Measurements

Analog, Discrete, or Digital

- **Analog Signal- magnitude is continuous in time**
- **Discrete Time Signal- magnitude at points in time**

  - sampling at repeated time intervals
- **Digital Signal- exists in discrete points in time**

  - magnitude is also discrete

Analog, Discrete, or Digital

Analog describes a signal that is continuous in time. Because physical variables tend to be continuous, an analog signal provides a ready representation of their time-dependent behavior.

Examples: voltage in a circuit

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Analog, Discrete, or Digital

...a discrete time signal, for which information about the magnitude of the signal is available only at discrete points in time. A discrete time signal usually results from the sampling of a continuous variable at repeated finite time intervals.

Examples:

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Analog, Discrete, or Digital

A digital signal has two important characteristics. First, a digital signal exists at discrete values in time, like a discrete time signal. Second, the magnitude of a digital signal is discrete, determined by a process known as quantization at each discrete point in time.

Examples:

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Static or Dynamic

Signals may be characterized as either static or dynamic. A static signal does not vary with time.

A dynamic signal is defined as a time-dependent signal. In general, dynamic signal waveforms, y(t), may be classified as shown in Table 2.1.

Deterministic or Non-Deterministic

A deterministic signal varies in time in a predictable manner, such as a sine wave, a step function, or a ramp function, as shown in Figure 2.5. A signal is steady periodic if the variation of the magnitude of the signal repeats at regular intervals in time.
Also described in Figure 2.5 is a nondeterministic signal that has no discernible pattern of repetition. A nondeterministic signal cannot be prescribed before it occurs, although certain char- acteristics of the signal may be known in advance.

Deterministic or Non-Deterministic

Table 2.1 Classification of Waveforms

I.	Static	$y(t) = A_0$
II.	Dynamic	
	Periodic waveforms	
	Simple periodic waveform	$y(t) = A_0 + C\sin(\omega t + \phi)$
	Complex periodic waveform	$y(t) = A_0 + \sum_{n=1}^{\infty} C_n \sin(n\omega t + \phi_n)$
	Aperiodic waveforms	
	Step[a]	$y(t) = A_0 U(t)$ $= A_0$ for $t > 0$
	Ramp	$y(t) = A_0 t$ for $0 < t < t_f$
	Pulse[b]	$y(t) = A_0 U(t) - A_0 U(t - t_1)$
III.	Nondeterministic waveform	$y(t) \approx A_0 + \sum_{n=1}^{\infty} C_n \sin(n\omega t + \phi_n)$

[a] $U(t)$ represents the unit step function, which is zero for $t < 0$ and 1 for $t \geq 0$.
[b] t_1 represents the pulse width.

Table 2.1 : Theory and Design for Mechanical Measurements